Cabling Standards and Guidelines
Commonwealth of Massachusetts

Information Technology Division

Cabling Standards and Guidelines

Version 2.2
August 2002

Document History

Date	Version Number	Summary
1995	Version 1.0	Developed by the Network standards subcommittee of the Governor's Advisory Council on Information Technology (GACIT), chaired by James Herman and comprised of personnel from various Commonwealth agencies.
	Version 2.0	Revisions drafted by ITD's Strategic Planning Bureau with input from other ITD staff and the wiring blanket contract vendors.
July 1998	Version 2.1	Revisions drafted by ITD's Strategic Planning Bureau with the assistance of GTE Internetworking.
August 2002	Version 2.2	Revisions drafted by the Wiring Standards and Guidelines Group chaired by Joseph Hickey, ITD Telecommunications System Manager

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Document Authors

Foreword

A well designed and implemented generic cabling system within Commonwealth buildings can save agencies significant dollars and can make it much easier for the Commonwealth to implement new Information Technology systems. As an analogy - one does not worry when moving from one office to another whether there will be power in the new office, or whether they will be able to plug in and use their favorite desk lamp; a generic cabling system can provide the same level of functionality and ubiquity for telecommunications and office computer systems.

This revision of the Cabling Standards and Guidelines has been drafted by the Wiring Standards and Guidelines group chaired by Joseph Hickey and comprised of personnel from various Commonwealth agencies and industry professionals. For a list of group participants please, see the Document Authors section at the end of this document.

This revision of the Cabling Standards and Guidelines document updates requirements to conform to the latest industry standards and practices. The design of non-proprietary cabling standards is a very active area of work within the industry, and the Commonwealth. This document takes advantage of the Commonwealth's experience and the relevant body of work by referring to current industry standards and practices from the ANSI, TIA/EIA, IEEE, and BICSI whenever possible. In the same vein however, industry practice will continue to change, and therefore there will be a continued need to update this document accordingly. Please contact the Information Technology Division at 617-626-4400 with your comments, suggestions, and questions.

1.0 Introduction

The purpose of a cabling system within a building or group of buildings is to provide interconnection between communication devices. These devices can be telephones, computer terminals, personal computers, faxes, and the devices such as servers, bridges, and routers that make up a Local Area Network (LAN) and Wide Area Networks (WAN).

In a small office with only a few computers, it is a fairly straightforward exercise to interconnect the devices as needed. However, once there are more than a handful of machines, it is necessary to use a structured cabling system to

interconnect them. This cabling system shall be a generic structured cabling system, which can support both your current and future communication systems.

A generic structured cabling system based on unshielded twisted pair cable, which is what this document addresses and provides the following benefits for the Commonwealth:

· Support for multi-vendor equipment and services

· Improved management of building space resources

· Reduced costs for cabling installation, support, and management

· Reduced training requirements for personnel

· Consistency of cabling at different locations

· improved troubleshooting and fault isolation

· Improved ability to manage system moves, adds, and changes

· System based on proven ANSI, TIA/EIA, IEEE and BICSI industry standards

Given all of these benefits, there is virtually no reason today to establish a proprietary cabling scheme for the type of office environments used by Commonwealth agencies and departments.

2.0 Industry Standards and Practices

This document is based on industry standards and we often refer to them rather than repeating sections from them in this document.

The most relevant standards are noted below. These standards and related documents are available for viewing at ITD.

· EIA/TIA-568-B1, B.2, B.3 Commercial Building Telecommunications Cabling Standard and its appendix, and addendums as issued.

· ANSI/TIA/EIA-569-A569-ACommercial Building Standard for Telecommunications Pathways and Spaces

· EIA/TIA-570 -A Residential and Light Commercial Telecommunications Cabling Standard

· EIA/TIA-606 Administrative Standard for the Telecommunications Infrastructure of Commercial Building

· ANSI/TIA/EIA-607 Commercial Building grounding and bonding requirements for telecommunications.

· ANSI/TIA/EIA-758 Customer –owned outside plant telecommunications standards.

· BICSI Telecommunications Distribution Methods Manual

· FCC Docket 88-57 and related rules regarding inside wire and demarcation points.

· IEEE 802.3 Specifications and associated sections

· The National Electrical Code (NEC) NFPA-70

· National Electrical Safety Code NESC

The Electronics Industry Alliance (EIA) and Telecommunications Industry Association (TIA) American National Standards Institute (ANSI) are large industry trade groups with memberships drawn from all facets of the telecommunications industry. Technical committees draft ANSI/ EIA/TIA standards and these standards are reviewed every five years. The cabling standards noted above detail the architecture, engineering, cable specification and management of cabling systems. BICSI stands for Building Industry Consulting Service International, Inc. and it is an industry organization that provides training and certification in this area The BICSI manual provides a detailed description of cabling layout and installation. The IEEE is a professional engineering society. IEEE standards specify LAN architecture and engineering. ANSI is the American National Standards Institute responsible for issuing of documents. FCC is the Federal Communication Commission. NFPA is the National Fire Protection Association and is responsible for NFPA 70 National Electric Code (NEC).

3.0 System Overview

A cabling system can be divided into several different types of building blocks, which include specific subsystems and cabling components. Since the interconnection of these building blocks is a classic system-engineering problem, it is helpful to study each subsystem individually, and then describe how they interconnect. This is the approach we take in this document.

The major subsystems below are referenced from ANSI/TIA/EIA 568B.1 for a cabling system include the following:

- Horizontal cabling (clause 4);
- Backbone cabling (clause 5);
- Work area (WA OUTLET) (clause 6);
- Telecommunications rooms (TR) (clause 7);
- Equipment rooms (ER) (clause 8);
- Entrance facilities (EF) (clause 9);
- Administration

Combined Fiber and Copper Backbone

The following figure illustrates a typical backbone arrangement for an installation requiring both voice and data services at the user stations.

Example of combined copper/fiber backbone supporting voice and data traffic

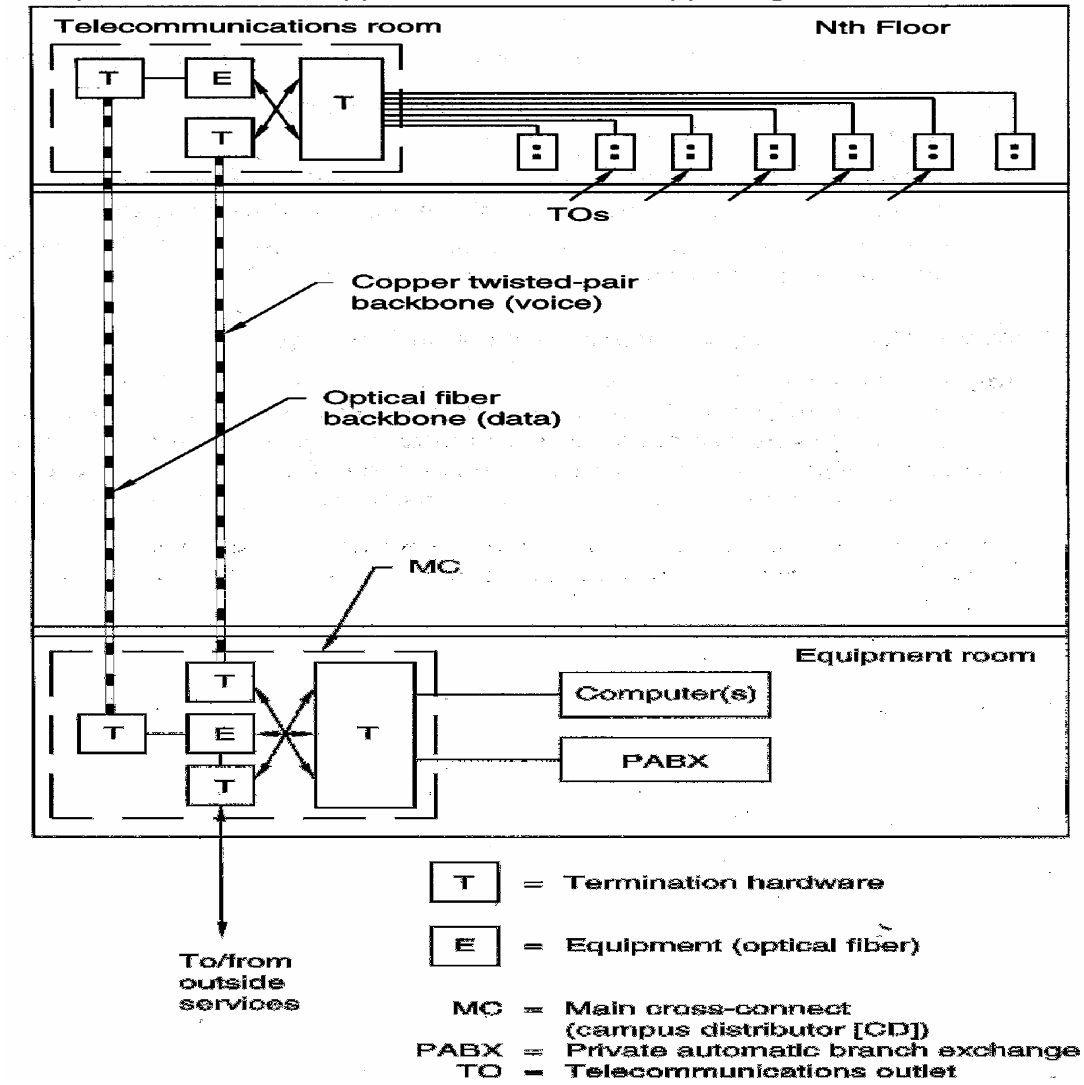

Figure -1

The relationship between these subsystems can be seen schematically in Figure 1. The horizontal cabling distribution system is used to connect each user's telephone and computer equipment to the required communications systems on that floor.

The backbone cabling distribution system provides the means of inter-connection of data and voice communications between telecommunication rooms including inter/and intra building cabling. The cables that are used for this include both copper and fiber optic cables. There may be more than one backbone cabling distribution system within a building since it is often practical from an implementation standpoint to logically subdivide the building. This is also done for disaster backup and redundancy.

The work area components extend from the telecommunications outlet/connector end of the horizontal cabling system to the workstation equipment. The workstation equipment can be any of a number of devices including but not limited to telephones, data terminals, and computers.

A Telecommunications room (TR) is an enclosed spaced for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and horizontal cabling.

Equipment rooms (ERs) a centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of its nature or complexity.

The entrance facility (EF) is an entrance to a building for both public and private network service cables (including antennae) including the entrance point at the building Wall and continuing to the entrance room or space. The components in this space consist of the cables, connecting hard Ware, protection devices, and other equipment needed to connect the outside plant facilities to the premises cabling. These components may be used for regulated access providers (e.g. local telephone companies); private network customer premises services, or both. The demarcation point between the regulated access providers and the customer premises cabling may be part of the entrance facility.

Basic administration information is covered in various locations throughout this Standard. Detailed information regarding administration referred to ANSI/TIA/EIA-606.

4.0 System and Cabling Topology

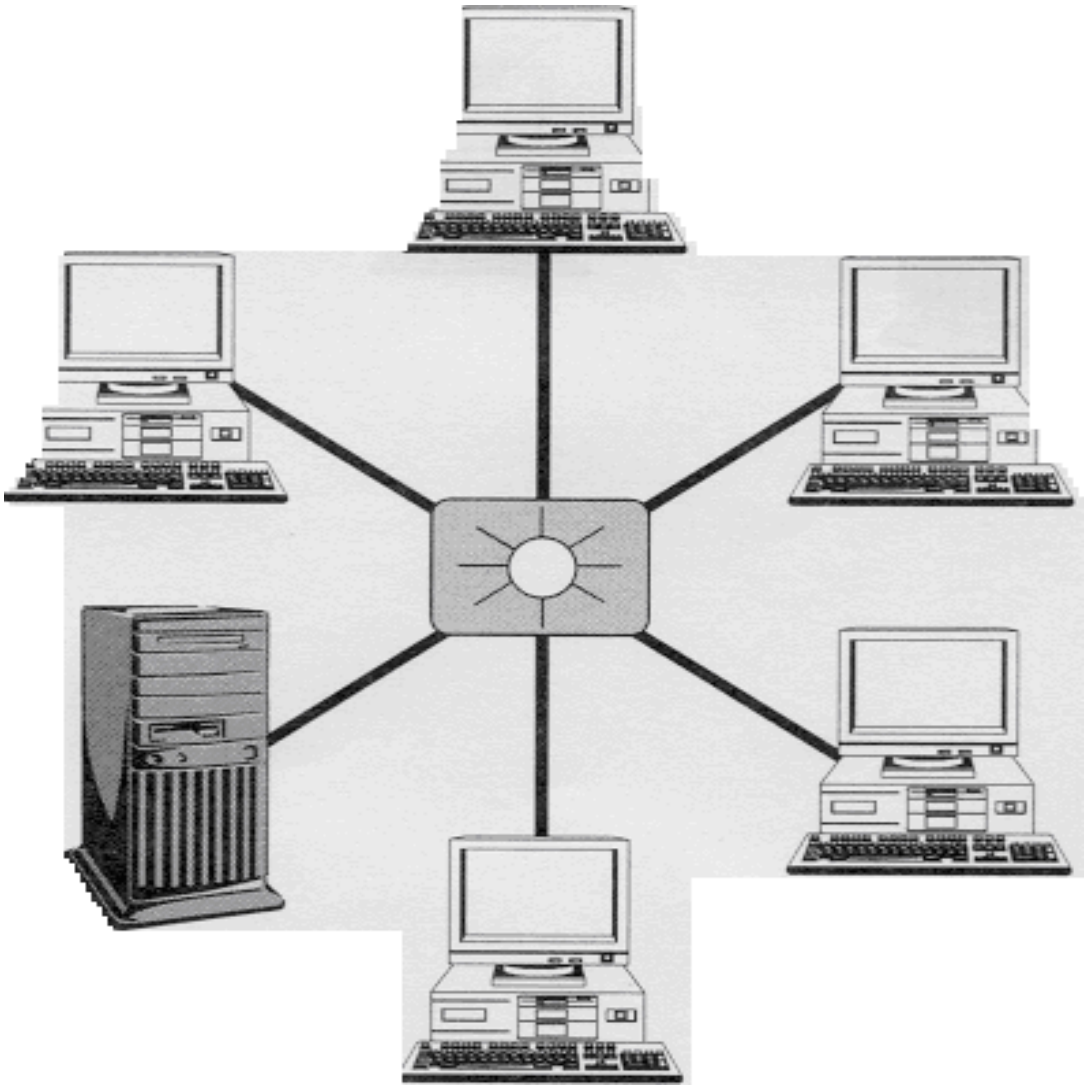

Figure-2

The Commonwealth's standard for cabling topology is the star configuration. Star topology is a topology which telecommunications cables are distributed from a central point. The use of this star topology means that cables should not be run directly between adjacent floors to interconnect equipment. For example, assume that it was necessary to connect a terminal on the 12th floor to a computer system on the 14th floor in a building, which has a MC, located on the 10th floor. In this case, a cable should not be run between these two floors. Rather, cables from the TR on each floor, which connect to the MC, should be used, and the connection made via patch panels located in the MC. This is the case for both fiber and copper connections.

5.0 Specification of Cable and Communications Outlet

This standard specifies only two types of media for use within Commonwealth buildings: unshielded twisted pair (UTP) and multimode fiber (62.5/125 or 50/125) fiber optic cable. The use of other media such as shielded twisted pair (STP) and coax should be avoided since they provide no advantage and are more expensive and difficult to install and maintain. A minimum three ports per WA Outlet, one voice, two data, unless otherwise specified by agency.

Category 6 UTP is required for both voice and data communications.

· For voice, horizontal station cable to all locations will consist of one (1) unshielded, 4 pair, 24 gauge copper, solid conductor, twisted pair category 6 cable enclosed by a thermoplastic jacket.

· For data, horizontal station cable to all locations will consist of two (2) unshielded, 4 pair, 24 gauge copper, solid conductor, twisted pair, and category 6 or higher rated cable as amendments are made to industry standards and enclosed by a thermoplastic jacket.

· As the industry and emerging technologies allow amendments to this document will be included to satisfy user needs.

Cable jackets may be of different materials to meet different UL ratings, but are generally rated for either normal in-wall installation or plenum installation. Commercial buildings usually use plenum-rated wire because at least some of their runs are through air plenums (such as the space above suspended ceilings) associated with heating and cooling systems (HVAC). **Building code usually requires plenum-rated wire to ensure a fire is less likely to cause burning insulation to contaminate the air system**. In addition to the category printed on the cable jacket, cables have a fire rating with codes like MPP (Multi-Purpose Plenum), CMP (Communications Plenum), and CMR (Communications Riser). Cables to be run within plenums should have a fire rating code of CMP or MPP.

Plenum-rated communications cables shall be third party NRTL listed in accordance with article 800.50, through 53. Plenum-rated fiber optic cables shall be third party NRTL listed in accordance with NEC sections 770-51 through 53. CMP, (Plenum Cable) for use in plenum areas (air ducts) must pass UL 910 test for smoke and flame spread).

ALL CABLE MUST MEET THE REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE (NEC) EXCEPT WHERE OTHER AUTHORITIES OR CODES IMPOSE A MORE STRINGENT REQUIREMENT OR PRACTICE. PARTICULAR DILIGENCE TO THESE CODES MUST BE USED IF CABLE IS TO BE RUN WITHIN AIR PLENUMS.

The technical specifications of category 6 UTP are currently defined in TIA/EIA 568-B.2.1. Category 6 cable is characterized for operation up to 250 MHz and it

is intended for data applications that operate up to 1000 Mbps. This means that category 6 cable can easily support 10BASE-T Ethernet at 10 Mbps, 100 Mbps Ethernet or 1000 Mbps Ethernet. It can also support several standard ATM transmission options. This document requires the use of this cable for voice and data so that once the cable is installed; it has the greatest breadth of applications. (Note however that if category 3 cable has already been installed for data, it does not necessarily need to be replaced. Replacement will be dictated by the speed requirements of the data application.)

The general layout for floor cabling is shown in Figure 6. The maximum length of the horizontal subsystem for data applications should be 90 meters (295 feet) independent of media type. This is the actual cable length, not the walking distance, from the termination in the TR to the device in the work area outlet (Wall). The length of the data patch cords in the cross-connect facilities, including voice horizontal cross connect, and the data patch cords that connect horizontal cabling with equipment or back bone cabling shall not exceed 5 meters in length.

Telecommunications Cable shall not be run near any source of EMI. Required clearances for electromagnetic isolation shall be a minimum of 6 inches, in accordance of the guidelines in ANSI TIA/EIA 569-A and Article 800 of ANSI/NFPA 70.

The termination of the voice and data cable within the workspace is done at the WA

Outlet. The WA Outlet is the modular interface used to connect the horizontal cabling to

the user's equipment. Each WA Outlet shall have a minimum of three separate RJ45

modular connectors - one for voice and two for data. Each modular connector will

terminate the UTP cable in an eight-position modular jack, which meets the requirements

of EIA/TIA-568-B.2.1. All four pairs shall terminate at both ends. One end of each

horizontal cable shall terminate in an 8-position, eight conductor category 6 modular

jack. Splices and bridge taps are not allowed. The termination cabling shall be T568B

configuration.

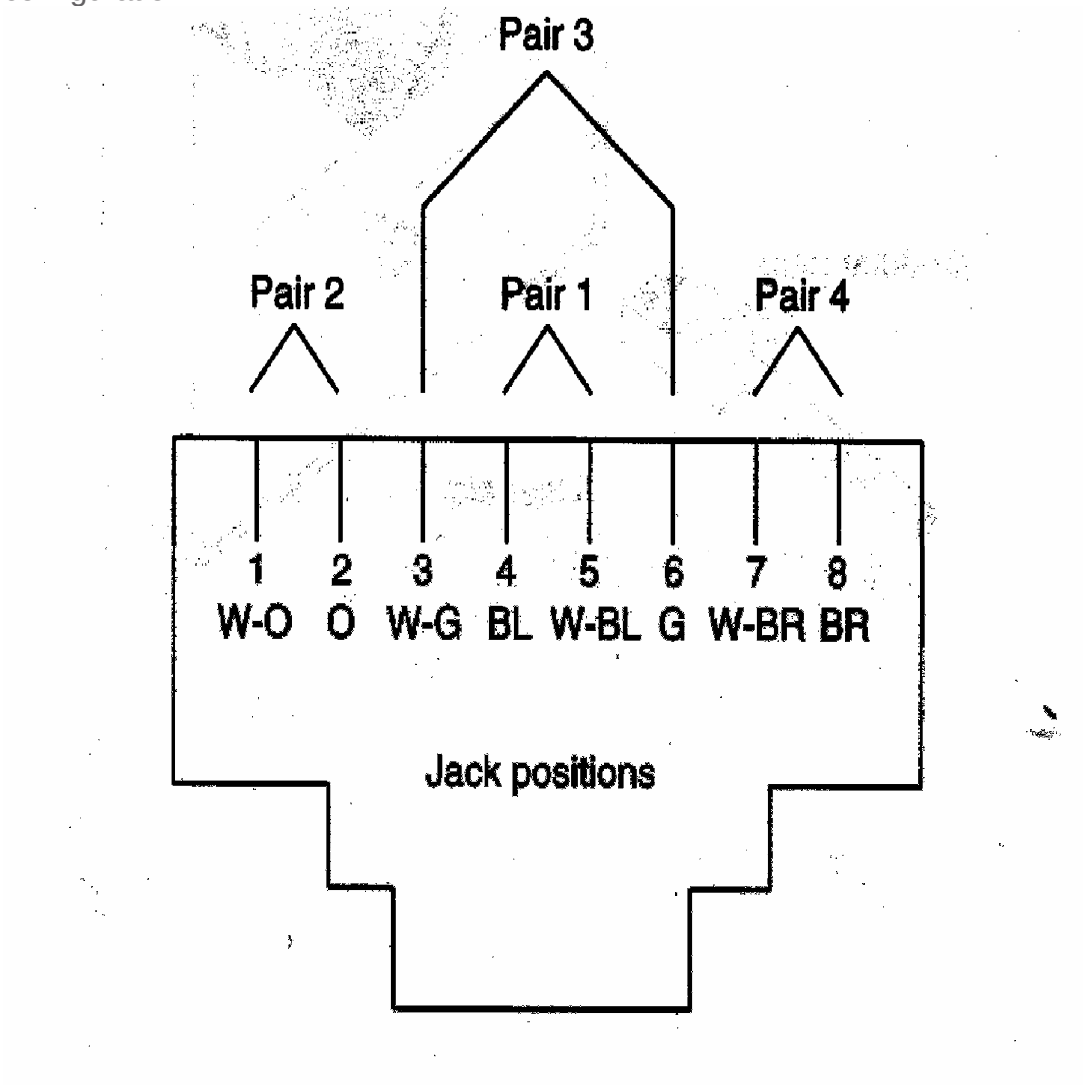

Figure-3

The modular connectors should be flush mounted in a WA Outlet, or by other secure means if WA Outlet mounting is not possible. Each workspace or work area shall have a minimum of one WA Outlet regardless of the size of the area. Private offices of approximately 100 square feet should have two WA Outlets and offices larger than 150 square feet should have 3 WA Outlets. Conference rooms and reception areas should have at least one WA Outlet. The number of WA Outlets in areas, which are used for printers, FAX machines, copy machines, etc., should be determined based on the anticipated use.

Both copper and fiber optic cable will be used within the Backbone cabling system (riser backbone system). All cable will be run in the star topology between the MC the building ER and each TR as previously described. Backbone cable for voice shall terminate four copper pairs per voice station with a minimum of 25% growth available to the next highest 100 pair. This voice cable will be a minimum 100 pair 24 gauges with overall jacket. All riser cable must meet NEC and fire codes. Riser cable for data shall be optical fiber. (Note however that if copper has already been installed as riser cable, it does not need to be replaced until the usage or application requires the installation of fiber.) There should be at least 24 strands of fiber optics installed between the MC/ER and each TR. If more than one TR is located on a floor, the need for distribution cable (fiber optic or UTP cable) between them should be determined as part of the system cabling design.

Additional requirements for these cabling components are summarized in an appendix to this document.

6.0 Specification of Telecommunications Rooms (TR)

There are three different types of TRs and they each support critical functions as part of the building cabling system. In general, each room must be large enough to accommodate the cabling and equipment, which will be located within them, plus additional space allocated for growth. The general environmental requirements include sufficient power and HVAC, plus they must be secure, and they must meet all applicable building and safety codes.

Telecommunications room (TR) is an enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and horizontal cabling. There may be one or more TRs depending on the size and layout of a floor. The TRs should be centrally located to accommodate cable routing to each location served by that TR without having to penetrate or pass around architectural barriers. The TR may serve as the center of the star topology for cabling and cable distribution for that floor or portion of the floor. Cabling from the TR is distributed to each work space served by that TR; this cabling can be distributed via a number of methods depending upon building and electrical codes, fire safety codes, etc. The most common methods are conduit, cable raceway systems, cable suspension (above a dropped ceiling) and various under floor systems. The cable distance between the TR and any workspace must be no more than 90 meters.

The equipment in the TR may include cabling cross connects and patch panels, punch down blocks, fiber patching equipment, etc. The TR may also contain communications equipment such as cabling hubs, terminal servers, and Ethernet bridges. This equipment is modular, available from multiple vendors, and is generically known as a smart hub. The Logical Network Architecture Guidelines

defines the combination of this communications equipment as the Group Hub (GH). LNA guidelines can be found at the following website. http://www.state.ma.us/itd/spg/publications/standards/netarch/index.htmThe TR should be large enough (with sufficient power and HVAC) to contain both the mechanical cabling systems and the communications equipment. If this is not possible, the communications equipment should be located in the ER, or a space on the floor with the correct HVAC and support systems. ***It is imperative that the placement of equipment in the TR meets all applicable building, fire and safety codes.***

Building Entrance Facility (BEF) is the point of demarcation between the communication facilities provided by a telephone company (access provider, which could be an Incumbent Local Exchange Carrier, Competitive Local Exchange Carrier, or a Competitive Access Provider) and the building's communication facilities. The actual physical point of interconnection to the carrier provided telephone services is typically a standard Telco company jack, or other means as specified in the applicable tariffs.

In single tenant buildings, the demarcation point BEF is generally located within 50 feet of exiting the entrance facility conduit of the telephone company lightning or surge protectors. These are safety devices, which the telephone company places on their lines at the location where they enter the building. In multi-tenant buildings, a telephone company may designate a single room in the basement as the demarcation point, (BEF) or they may designate multiple demarcation points at various locations in the building.

Note that with the emergence of Competitive Access Providers and Competitive Local Exchange Carriers, a given building may receive service from more than one Telephone Company. In such cases, there may be a need for separate Building Demarcation Points for each carrier, preferably using separate rooms and possibly separate entrance conduits. In many cases, a CLEC or CAP will deliver service directly over fiber optics. Such installations have fewer physical pairs and may lack the lightning protection characteristic of copper, but will require electrical service to a fiber optic terminal and/or multiplexor, as well as associated lighting and ventilation.

It is important to note that the BEF may be located somewhere other than within the ER, and in these circumstances, sufficient cable conduit must be installed between these locations. It is not unusual for the demarcation point to be located in the basement and the ER to be located on a higher floor. Regardless of the location of the carrier's demarcation point, the MC should serve as the main communications room.

Equipment Room (ER) is a centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of its nature or

complexity. The Main Cross connect (MC) is normally located in the main equipment room for cross connection and interconnection of entrance cable, first level backbone cable and equipment cables. This room may also serve as the BEF. The MC is used to distribute communication services to all of the Telecommunication Room (TR) within the building and as such, it can be viewed as the center of the star for cabling and cable distribution. The room contains the necessary cabling cross connects, punch down blocks, fiber patching equipment, etc. to connect to each TR within the building.

The MC may also contain the shared communications equipment for the building. For voice, the room contains the PBX, or other telecommunications equipment, and for data, the MC contains the shared data communications equipment such as routers, hubs, switches which will all collapse to the wide area network backbone. The Logical Network Architecture Guidelines defines the combination of this communications equipment as the Core Hub (CH) for the building.

Every building should have one MC centrally located in order to minimize the cable distances within the building. In a high-rise building, this means the MC should be located on a middle floor even though the BEF might be located on the first floor or in the basement. If a number of Commonwealth agencies lease multiple floors within a commercial building, there might be a MC built for their exclusive use. There may be two or more MCs within a very large building.

The technical and architectural requirements for a MC can be found in the ANSI/TIA/EIA-569-A standard and the BICSI Telecommunications Distribution Methods Manual (TDMM). General room requirements are summarized in an appendix to this document, but it is important to note that the MC must be a secure room and that disaster backup plans must be in place for this facility.

Note that if GH equipment must be located in the TR, then the data functions of the TR are subsumed by the MC, as the standard fiber optic data risers are designed to end at the GH. The total distance from the CO to the GH must still not exceed 100 meters. The technical and architectural requirements for a TR can be found in the ANSI/TIA/EIA-569-A standard and the BICSI Telecommunications Distribution Methods Manual (TDMM). General room requirements are summarized in an appendix to this document, but it is important to note that the TR must be a secure room and that disaster backup plans must be in place for users served from this room.

7.0 Administrative and Management Requirements

The administration of the telecommunication infrastructure within a building requires that documentation of the building's cabling be created and then maintained on an ongoing basis. Administration also includes setting policies on the installation and upgrading of the system, access to the building and TRs and planning for disaster recovery. All of these issues and details are described at

length in the ANSI/TIA/EIA-606 standard. The most important point however is that a single organization should be responsible for the management and administration of the physical cabling infrastructure within a building. This approach is an integral part of this policy.

Appendix A: Guidelines for Telecommunications Rooms

The following are the basic guidelines that should be adhered to in the construction and renovation of Telecommunication Rooms (TR). These rooms, which are also known as wiring closets or Intermediate Distribution Frames (IDF), are to be set aside on each floor for the exclusive purpose of housing the communications equipment and related cabling that serves the specific area of the building. These are minimal requirements only; a detailed design is required for each such room within a building. These guidelines should reflect the most current ANSI/TIA/EIA and BICSI standards, before a final design is approved. Rooms in current buildings that are being renovated should try to meet these guidelines if possible.

It is imperative that the TR and equipment placed within the TR meet all applicable building, fire and safety codes.

The basic guidelines for TR ("rooms") include the following:

a: Rooms should serve one floor only and rooms should be physically located on the floor. Rooms which serve an area of approximately 10,000 square feet should be 10' x 11' in dimension. Rooms which serve an area of 5,000 square feet should be 10' x 7' in dimension.

b: All interior walls in closets should be covered, floor to ceiling with 3/4" plywood that is raised away from the wall a minimum 1&3/4".

c: All interior walls in rooms should be fire rated or treated on both sides with 2 coats of white fire retardant paint, which meets applicable fire codes.

d: There should be, at a minimum, two (2) duplex convenience outlets on each wall of the room at a minimum at 6ft intervals around perimeter of room. Dedicated service should be provided as required for the communications equipment. All outlets should be backed up via the building UPS if available.

e: Rooms should not have a false or drop ceiling.

f: Flooring should be tile or other finished surface to keep dust at a minimum.

g: No building water or steam carrying pipes shall run through or above the room, except for sprinkler systems if required. If sprinkler heads are required they shall be of high temp rating and caged.

h: Lighting should be maintained at 50-foot candles, measured at 3 foot above floor level.

i: Lighting should be able to be turned on/off via a Wall switch located immediately inside the door.

j: Door should be minimally three feet (3') wide and should swing open out of the room.

k: Doors should lock from outside access; exiting from closets must always be permissible.

l: Floor loading must be a minimum of 100 lb. per square feet.

m: HVAC should be included in the design of the room in order to maintain a room temperature of 64-75 degrees Fahrenheit with the full complement of equipment in the room.

n: Relative humidity should be maintained between 30% and 50%.

o: Riser cable access into TR(s) shall be via four-inch (4") conduit or sleeved cores. Exact amounts of conduit required on a per closet basis must be determined based upon the amount of fiber and copper cable that must be supported in each TR (see ANSI/TIA/EIA-569-A for guidelines). A minimum of two (2) additional cores/conduits must be provided in each room for future growth.

p: All conduits/coring should be kept six inches (6") or less from walls whenever construction permits. All cores should be in single row. All cores should be kept in same relative proximity in stacked TRs.

q: All penetrations must be sealed with a fire stop, which meets applicable code.

r: Rooms that are not equipped with raised flooring should have 12" ladder rack installed along each plywood wall with an additional 12” ladder rack above each equipment rack or cabinet. Ladder rack must be securely installed and must provide a minimum clearance of 9'-0" above the floor.

s: Station cable access, when not via raised floor, should be via 4" sleeves located above door level, and cable should run directly onto ladder rack within room.

t: Pull strings must be installed in all conduits and sleeves.

Appendix B: Guidelines for Equipment Room

The following are basic guidelines that should be adhered to in the construction and renovation of Equipment Rooms (ER). These rooms, which are also known as the Building Entrance Facility (BEF), Main Distribution Frame (MDF). Equipment Rooms are the primary communications room for a building or facility. These are minimal requirements only; a detailed design is required for this room. These guidelines should reflect the most current ANSI/TIA/EIA and BICSI standards before a final design is approved. Rooms in current buildings that are being renovated should try to meet these guidelines, if at all possible.

It is imperative that the Equipment Rooms and equipment placed within the rooms, meet all applicable building, fire and safety codes.

The basic guidelines for (ER's) include the following:

a: (ER) should be sized to meet the requirements of the current and planned communications equipment. When requirements are not known, the ANSI/TIA/EIA 569-A standard recommends that there be a minimum of 0.75 square feet of space for every 100 square feet of workspace. (A minimum of 150 square feet is recommended.)

b: All interior walls in closets should be covered, floor to ceiling, with 3/4" plywood that is raised away from the Wall a minimum 1&3/4".

c: All interior walls in rooms should be fire rated or treated on both sides with 2 coats of white fire retardant paint, which meets applicable fire codes.

d: There should be, at a minimum, two (2) duplex convenience outlets on each wall of the room at a minimum of 6ft intervals around perimeter of room. Dedicated service should be provided as required for the communications equipment. All outlets should be backed up via the building UPS if available

e: Dedicated electrical service should be provided as required for the installed communications equipment and should be backed up via the building UPS.

f: Rooms should not have a false or drop ceiling.

g: Flooring should be tile or other finished surface to keep dust at a minimum. Anti-static protection should be used as required by equipment.

h: No building water or steam carrying pipes shall run through or above the room, except for sprinkler systems if required. If sprinkler heads are required, they shall be of high temp rating and caged.

i: Lighting should be maintained at 50-foot candles, measured at 3 foot above floor level. Lighting should be able to be turned on/off via a Wall switch located immediately inside door.

j: Doors should be minimally three feet (3') wide and should swing open out of the room. Doors should lock from the outside; exiting from the room must always be possible.

k: Floor loading must be a minimum of 250 lb. per square foot, or as required by equipment.

l: HVAC should be included in the design of the room in order to maintain a room temperature of 64-75 degrees Fahrenheit with the full complement of equipment in the room. Relative humidity should be maintained between 30% and 50%.

m: Riser and distribution cables leaving the room to building TRs and agency computer and communication room spaces should be via four-inch (4") conduits or sleeved cores. The exact number of conduits required should be determined based upon the amount of fiber and copper cable that must be supported in each closet, and each agency computer or communications room. Additional conduits or sleeved cores must be included in the design to provide for future growth.

n: If the Building Entrance Facility (BEF) is not located within the room, sufficient conduit must be run between these two locations. A minimum of four (4) additional four-inch (4") cores/conduits must be provided for future growth.

o: If the Building Entrance Facility (BEF) is located within the room, a minimum of fifteen feet of Wall space with backboards must be provided for terminations and related equipment.

p: If a second Building Entrance Facility (BEF) is provided to allow for second provider's entrance facilities, additional cores/conduits must be provided to that location. If more than one provider's BEF needs to be in the ER, their respective wall space and backboards must be kept separate and clearly distinguishable.

q: All conduits/coring should be kept six inches (6") or less from walls whenever construction permits.

r: All penetrations must be sealed with a fire stop, which meets applicable code.

s: Rooms should be installed with raised floors. Rooms that are not equipped with raised floors should have 12" ladder rack installed in a configuration, which supports the proposed equipment layout.

t: Pull strings must be installed in all conduits and sleeves.

Appendix C: Specifications for System Cabling and Components

The following are the basic specifications for system cabling and components. These are minimal requirements only; a detailed system specification and design is required for each installation. These specifications should reflect the most current ANSI/TIA/EIA and BICSI standards, before a final cabling design is approved. All cabling systems that are being updated shall meet these guidelines.

It is imperative that all cabling system components used within Commonwealth buildings meet all applicable building, electrical, fire and safety codes.

This appendix is divided into ten sections.

I. General System Specifications

1.1 All voice and data cabling should be neatly installed without using any electrical conduits, plumbing, heating, or air conditioning structures for support. Cabling must be routed so that it does not interfere with access to panels, switches, valves, or other maintenance systems.

1.2 All cables must be installed at least one foot from any fluorescent lighting unless contained in separate conduit, and four feet from other sources of electrical interference such as motors and generators.

1.3 All above-ceiling cable must be installed in cable trays or installed using a comparable method of support so that the cable does not lie loosely on the top of the false or drop ceiling.

1.4 All twisted pair cable must be tested by the installer to the latest industry standards to be compliant with category 6 specifications, (as appropriate). All fiber optic cable must be tested to the latest industry standards (ANSI/TIA/EIA 568 B.3). All test results must be included in the installation documentation.

II. Voice Twisted Pair Station Cable

2.1 Voice station cable must consist of one (1) unshielded, 4-pair, 24-gauge copper, solid conductor category 6, twisted cable. Hybrid cable, which meets the same category 6 technical specifications, is also acceptable.

2.2 All cable must be labeled clearly and legibly at both ends.

2.3 Station locations must be labeled on connection blocks and or patch panels in all TR and ER. .

2.4 Separate connection blocks or patch panels must be provided for station cables and riser/ horizontal cables.

2.5 At the IDF end of the voice station cable:

1. Cables must be terminated onto 110 type blocks or patch panels, (per agency specifications).

2. Cables must be cut down in numerical order.

3. Cables must include ten (10) feet of additional length, looped in the room to allow for future adjustment of blocks.

2.6 Cables must include ten (10) feet of additional length, looped, and secured above the ceiling or below the floor at the station outlet end to allow for future room rearrangements.

2.7 At the station and/or communications outlet end, cable must be connected to modular jacks per 568 B wiring scheme.

III. Data Twisted Pair Station Cable

3.1 Data station cable must consist of one (1) unshielded, 4-pair, 24-gauge copper, solid conductor twisted pair, category 6, cable at a minimum. To all cabled locations. Hybrid cable, which meets the same category 6 technical specifications, is also acceptable.

3.2 All cable must be labeled clearly and legibly at both ends.

3.3 Station locations must be labeled on patch panels at all TR and ER.

3.4 At the TR/ER end of the cable:

1. Cables must be terminated directly onto patch panels

2. Cables must be terminated in numerical order.

3. Cables must include ten (10) feet of additional slack, in the closet to allow for future adjustment of patch panels.

3.5 At the station and/or communications outlet end, the cable must be terminated in an 8 position, 8 conductor modular connector. (568 B Wiring Scheme).

3.6 Cables must include ten (10) feet of additional slack, secured above the ceiling at the station outlet end to allow for future room rearrangements.

3.7 Patch cables shall meet or exceed horizontal cabling category specifications at the TR.

IV. Communications Outlet Specifications

4.1 At the station and/or communications outlet end, **voice cable** must be connected to an 8 position, 8-pin conductor modular RJ-45 jack.

4.2 At the station and/or communications outlet end, **data cable** must be connected to, 8 position, 8 conductor modular RJ-45 jack.

4.3 Communication outlets located in building walls should be flush mounted in single gang electrical boxes with appropriately labeled faceplates.

4.4 Communication outlets located in movable and demountable partitions must be mounted in an integral raceway system. The use of adhesive backed surface mount boxes is specifically prohibited.

4.5 All outlets must be clearly identified with labels as to station type (voice and data) and terminating TR location.

V. Voice Riser/Distribution Cables

5.1 Conventional voice distribution cables must be 100-pair category 3, #24 gauge at a minimum. All riser cable must meet all applicable fire and safety codes.

5.2 If there is more than one TR located on a floor, distribution cable between these rooms must be included as part of the system cabling design.

5.3 All 100-pair cable must contain four (4) 25-pair binders.

5.4 Color code of each 25-pair binder must be as follows:

PAIR	COLOR CODE COMBINATION	
1	White/Blue	Blue/White
2	White/Orange	Orange/White
3	White/Green	Green/White
4	White/Brown	Brown/White
5	White/Slate	Slate/White
6	Red/Blue	Blue/Red
7	Red/Orange	Orange/Red
8	Red/Green	Green/Red
9	Red/Brown	Brown/Red

10	Red/Slate	Slate/Red
11	Black/Blue	Blue/Black
12	Black/Orange	Orange/Black
13	Black/Green	Green/Black
14	Black/Brown	Brown/Black
15	Black/Slate	Slate/Black
16	Yellow/Blue	Blue/Yellow
17	Yellow/Orange	Orange/Yellow
18	Yellow/Green	Green/Yellow
19	Yellow/Brown	Brown/Yellow
20	Yellow/Slate	Slate/Yellow
21	Violet/Blue	Blue/Violet
22	Violet/Orange	Orange/Violet
23	Violet/Green	Green/Violet
24	Violet/Brown	Brown/Violet
25	Violet/Slate	Slate/Violet

VI. Voice Riser/Distribution Cable Terminations

6.1 Voice riser/distribution cable must be run from the ER directly to each of the building's TR. All distribution cables must be terminated on 110 type blocks, or patch panels at floor TR and at the ER.

6.2 All termination blocks at the TR must be securely mounted and must not exceed 900 pair within a group with the bottom block at least 18" above the finished floor.

6.3 The first block must be a minimum of 6" in from the end of the backboard. Adjacent rows shall be 2.5" apart. Minor adjustments in row spacing are allowed to provide clearance of the mounting studs behind the backboards.

6.4 All blocks at TR must be mounted on fire retardant plywood backboards.

6.5 Riser distribution cable must include two pair per voice station with a minimum of 25% growth per TR, in multiples of 100 pair cables.

VII. Copper Data Riser/Distribution Cables

7.1 Data distribution cables must be 25-pair category 6 or greater, unless specific requirements dictate otherwise, #24 gauge. All riser cable must meet all safety and fire codes and must have a different jacket color than that cable supplied for voice riser.

7.2 If there is more than one TR located on a floor, distribution cable between these rooms must be included as part of the system cabling design.

7.3 All 100-pair cable must contain four (4) 25-pair binders.

7.4 Color code of each 25-pair binder must be as follows:

PAIR	COLOR CODE COMBINATION	
1	White/Blue	Blue/White
2	White/Orange	Orange/White
3	White/Green	Green/White
4	White/Brown	Brown/White
5	White/Slate	Slate/White
6	Red/Blue	Blue/Red
7	Red/Orange	Orange/Red
8	Red/Green	Green/Red
9	Red/Brown	Brown/Red
10	Red/Slate	Slate/Red
11	Black/Blue	Blue/Black
12	Black/Orange	Orange/Black
13	Black/Green	Green/Black
14	Black/Brown	Brown/Black
15	Black/Slate	Slate/Black
16	Yellow/Blue	Blue/Yellow
17	Yellow/Orange	Orange/Yellow
18	Yellow/Green	Green/Yellow
19	Yellow/Brown	Brown/Yellow
20	Yellow/Slate	Slate/Yellow
21	Violet/Blue	Blue/Violet
22	Violet/Orange	Orange/Violet
23	Violet/Green	Green/Violet
24	Violet/Brown	Brown/Violet
25	Violet/Slate	Slate/Violet

VIII. Data Riser/Distribution Cable Terminations

8.1 Data riser/distribution cable must be run from the ER directly to each of the building's TRs and must be terminated on patch panels.

8.2 All patch panels at TR shall be wall or rack mounted. All patch panels shall be in increments of 24 ports and be category 6 or higher.

8.3 The size of the riser distribution cables must be determined during system design.

IX. Fiber Riser and Distribution System

9.1 At a minimum, one (1) twelve (12)-strand fiber optic cable shall be distributed to each TR in the building from the ER. Fiber strands may be single mode (8.3/125 micron) or multi-mode (62.5/125 or 50/125 microns) or a combination thereof. This is a minimum; additional fiber cables should be installed as needed for current and future requirements. Consult your cabling vendor for a design to suit your requirements.

9.2 Fiber optic cable at each TR and or ER must be terminated in a wall or rack mounted enclosure that must accommodate at least twelve (12) patch cord terminations.

9.3 If there is more than one TR located on a floor, the installation of fiber cable between the rooms should be considered only if special circumstances exist.

9.4 All fiber strands must be terminated with SC or small form factor connectors. ST type connectors are acceptable to match existing connectors.

9.5 All fiber must be run through inner duct or conduit. The pathway must be clearly labeled as "FIBER OPTIC CABLE" and must be labeled with information on the fiber's termination point and the fiber's owner.

9.6 All fiber strands shall be terminated, labeled and tested. All unused connectors shall have dust covers installed.

X. Cable Documentation

10.1 The cable installer must provide clean and legible as-built cable drawings and records in both hard and soft copy as part of system installation. These drawings must, at a minimum, show the location and type of all communication rooms, communication closets, all distributing cable runs, and all outlets. Cable records must, at a minimum, include station location number, horizontal and riser distribution cable numbers, and all other information necessary to correlate cable runs and terminating locations. Cable records should also include the cable lengths; pair count/fiber counts for all distribution and outside plant cable (by segment) and the locations of any splices.

10.2 All cables must be labeled using a permanent marking system. Handwritten labels are not acceptable. All conduits carrying fiber cable and all voice and data riser or distribution cables must be labeled at ten-foot intervals on long runs, but not less than twice within a room. At a conduit end point, the label must

include information indicating distant end point (i.e. *Fiber Optic Cable to Floor 1, Closet "A").*

10.3 Labeling methods should be consistent throughout the system and should meet the reporting requirements of ANSI/EIA/TIA/ 606.

10.4 Installers of fiber cable must test the Loss Ratio of each fiber and provide the results to the agency(s)in hard and soft copies as part of the cable documentation.

Appendix D: Wireless System Cabling and Components

The following are the basic specifications for wireless system cabling and components. These are minimal requirements only; a detailed system specification and design is required for each installation. These specifications should reflect the most current ANSI/TIA/EIA, IEEE 802.11b specifications and BICSI standards, before a final cabling design is approved. Wireless systems and applications will need to meet enterprise standards currently under development by the Wireless Technology Planning Group chaired by the Information Technology Division.

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